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JERROLD

**IM
EDL**

**OPERATING and
MAINTENANCE
MANUAL
No. 1900**

INSTRUMENT SHOP

SWEEP GENERATOR

Model 900

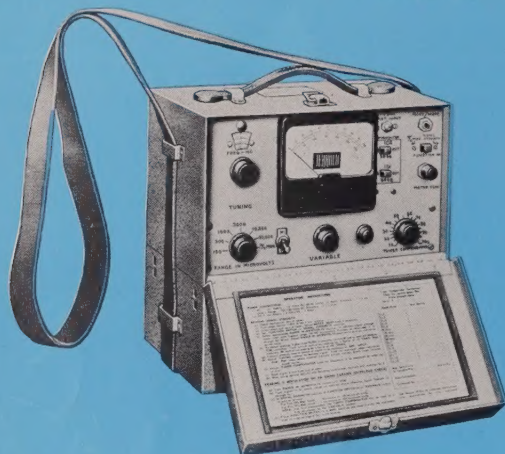


JERROLD ELECTRONICS CORPORATION
23rd & Chestnut Streets • Philadelphia 3, Penna.

TEST EQUIPMENT and ENGINEERED ACCESSORIES

for improved techniques and control in . . . Production,
Equipment Design, Laboratory and Field Research, and
RF Transmission.

VHF FIELD STRENGTH METER Model 704B



The Jerrold 704B direct reading field strength meter is a high quality, versatile and portable instrument designed for the accurate measurement of signal strength in the frequency range of 54 to 220 mc. The overall range of the instrument is 5 microvolts to 3 volts with an accuracy of ± 0.8 db. The versatility of the Model 704B is illustrated by a partial list of its applications.

FOR USE IN:

Field Intensity Surveys • Checking % AM Distortion of FM Amplifiers •
Checking % of Modulation of FM Carriers • Measuring Radiation •
Measuring and Locating Interference • Measuring Individual Video and
Audio Carrier Levels . . . and many other uses.

OSCILLOSCOPE PRE-AMPLIFIER Model SPR-100

Provides: Wide Band Detector (Flat from 100 KC to 250 mc)
Audio Amplifier (Gain—Over 100X)
Marker Injector (With Dual Inputs)

This unusual oscilloscope pre-amplifier features extremely low hum and noise level, excellent stability and 60 cycle square-wave response. Three position switch permits connecting the detector directly to the oscilloscope, through the amplifier with natural response, or through the amplifier with a high-pass response. Marker injector has special filtering to prevent distortion and gain control to adjust height of marker pip. Ideal for use with Jerrold Model 95 or 220 Sweep Generators. 75 ohm impedance.



HIGH SPEED-ELECTRICAL COAXIAL SWITCH Model FD-30

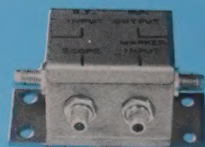
This electronic keyer consists of two coaxially-mounted mercury relays forming SPDT coaxial switches. Special circuitry for driving them at 30 CPS locked, with variable phase to the supply line.

Used with a sweep set-up, the keyer allows precise measurement of gain, loss and impedance match. Frequency response is "flat" from 0 to 220 mc. 75 ohm impedance.



DETECTOR Model D-85

A split type RF detector designed specifically for use with Jerrold Models 95 and 220 sweep generators. Model D-85 utilizes a voltage doubling circuit to permit outputs of up to 1 volt dc. The detector exhibits an output response flat within ± 1.0 db over the frequency range of 0.5 to 250 megacycles and is matched to 75 ohms with a VSWR of less than 1.06.



VARIABLE ATTENUATORS Model A-72 and A-21

Switch type, Variable RF Attenuators providing precise attenuation over the frequency range of 0 to 250 megacycles. The units are matched to 75 ohms with a VSWR of less than 1.05 and are capable of handling 500 milliwatts of power. Model A-72 attenuates from 0 to 82 db. Model A-21 attenuates from 0 to 21 db.



MATCHING TRANSFORMER Model T-372

Designed for positive impedance match between 75 and 300 ohms with a flat signal response over the entire frequency range of 50 to 250 mc.

ALIGNMENT JIG Model AJ-106

Capacity coupling alignment jig used where an RF signal must be inserted between stages of amplifiers or similar equipment. The AJ-106 is placed over a cold (dummy) tube and the alignment or test signal from the signal generator is connected to the jig.



FIXED RF ATTENUATORS Models PDC and PDL

Attenuator Pads using resistive Pi networks to provide a specified attenuation for use in 75 ohms circuits. Exhibit a VSWR of less than 1.2 to 1 over the range of 0 to 220 mc. The in-line tubular design permits convenient insertion into the coaxial line or direct connection to the equipment chassis. Model PDC is for chassis mounting. Model PDL for in-line mounting.



SOLDERLESS COAXIAL CABLE CONNECTORS "F" Series

A complete, integrated line of coaxial cable connectors and fittings designed expressly to meet the severest requirements for RF distribution systems, for RF laboratory use, for RF equipment and for general service work. Using only simple hand tools, the Jerrold solderless connectors can be permanently bonded to all types of RG-35, RG-11, RG-59 and RG-6 type cables in just a fraction of the time usually required to make soldered connections. Each Jerrold fitting is carefully machined of brass and is heavily silver plated to maintain low contact resistance through years of service. Shunt capacitance and impedance mismatches are held to extremely low levels—to the extent that their VSWR is less than 1.04 up to 200 megacycles. The "F" series connectors are so designed that the smallest fitting can be mated to any of the standard 75 ohm coaxial cables mentioned above.



MODEL F-59



MODEL F-61



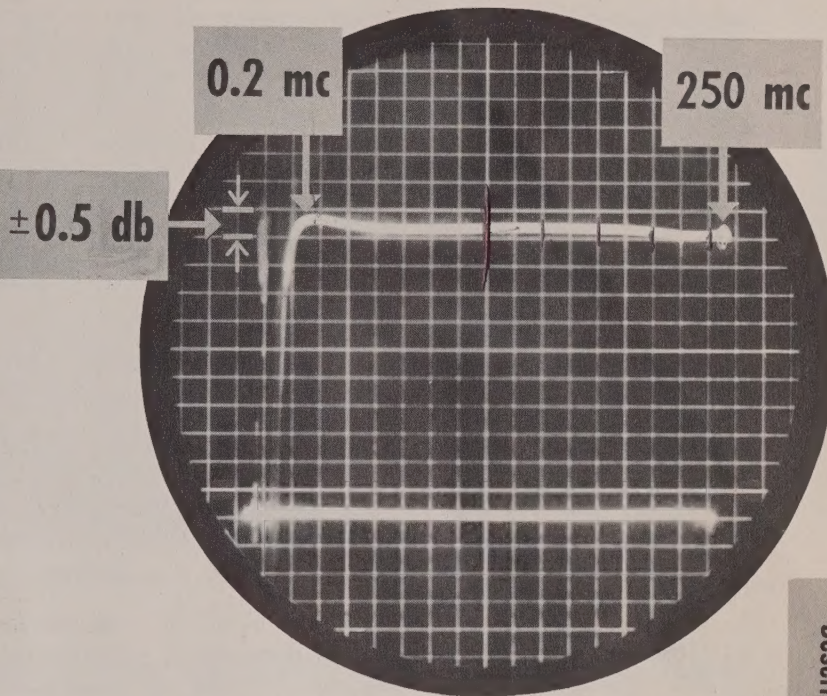
MODEL AF-101

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SWEEP GENERATOR

Description

The JERROLD Model 900, Wide Band Sweep Frequency Generator is an instrument of unusual versatility. In two ranges—"VHF" and "UHF"—the instrument supplies a sweep signal with center at any frequency from 200 KC to over 1,000 MC and with sweep widths as broad as 300 MC and as narrow as 100 KC. The RF output—carefully monitored by matched, crystal diodes feeding a two-stage AGC amplifier—is flat within ± 0.5 db over the entire "VHF" range; 200 KC to 250 MC. At a maximum sweep width of 300 MC, the total RF output variation of the "UHF" range—250 MC to 1,000 MC—is less than ± 3 db. The mechanical and electrical stability and the extreme constancy of its output recommend the Model 900 Generator for use wherever careful and highly accurate sweep frequency measurements are to be made.



Features

Supplies a sweep signal at any frequency from 200 KC to over 1,000 MC
... with sweep widths as wide as 300 MC and as narrow as 100 KC.

OSCILLOSCOPE PREAMPLIFIER

A built-in amplifier provides a gain of one hundred times (100 X) between the detector output and the scope's vertical input. This amplifier may be switched out when not required. The same switch allows selection of a special "filter" circuit for use with delay line measurements.

PHASE ADJUSTMENTS

Phase adjusting as well as phase reversing switches are provided both in the horizontal deflection circuits and in the blanking circuits so that the positioning of the pattern on the screen of the oscilloscope can be properly phased horizontally. Either the forward trace or the return trace can be removed at will by the blanking circuit.

MARKER CIRCUITS

A flexible arrangement allows injecting a center frequency marker as well as sideband markers for any of the frequencies to which the sweep can be tuned. The sideband marker arrangement is particularly convenient where it is desired to mark frequencies which are spaced a small distance away from a high, center-frequency. A built-in marker amplifier provides ample gain in the marker channel to ensure clear indications from weak marker signals. The frequency response of the marker amplifier is controlled to give the clearest possible marking with no distortion of the trace.

RUGGED MECHANICAL DESIGN

All parts of the sweep oscillator circuit are precisely machined from rugged, silver plated brass pieces. A slider of unique design moves in a rhodium-plated tube to provide long and trouble-free operation. The entire sweep unit is mounted on shock mounts within the cabinet to prevent transmission of external shocks to the sweep mechanism, as well as to prevent any mechanical hum being transmitted to the work-bench on which the unit is mounted.

The center frequency is adjusted by a large, easily-turned knob on the front panel and calibrated scales are provided indicating the center frequency to which the sweep is tuned. To allow easy setting of the center frequency when very narrow bandwidths are being used, a center frequency vernier is provided which permits making a small shift of center frequency with great precision.

The main bandwidth control is a high resistance potentiometer providing smooth stepless variation of bandwidth from maximum down to a low value. For extremely careful setting of bandwidth when narrow width is being used, a vernier bandwidth control is provided.

BUILT-IN FILTERS

Carefully designed filters are interposed between the sweep unit and the output terminals to prevent transmission of frequency components other than those desired, thus ensuring that the output voltage, measured at that point by an untuned detector, is a true indication of the sweep output.

BUILT-IN DETECTOR

A built-in detector circuit is provided so that the output of the sweep can be checked conveniently at all times. The crystal diodes in this detector are carefully matched with those in the AGC circuit of the sweep in order to obtain flat response over the extremely wide band provided in this sweep.

COMPLETE VOLTAGE REGULATION

All supply voltages for the Model 900 are obtained from a Sola Regulating Transformer, thus ensuring absolute stability and freedom from changes in sweep operation due to line voltage variations. In addition to this, the reference voltage for the AGC section is obtained from an OD-3 gas tube regulator to ensure extremely constant output.

JERROLD ELECTRONICS CORPORATION,
23rd and Chestnut Sts., Phila. 3, Pa.

JERROLD

General
Description

CONTROLS

The following controls are found on the front panel of the Model 900 (Figure 1).



FIGURE 1. Model 900

1. The *power switch* which turns the unit on or off.
2. The *frequency switch* which selects either the VHF frequency range or the UHF range.
3. An *AGC control* which sets the level at which the AGC operates. This is normally set at the maximum output at which the AGC functions properly.
4. A *blanking switch* which blanks one of the two traces back to zero output in the ON position, or which allows output during both forward and return trace in the OFF position.
5. A *blanking phase adjustment* and a *blanking phase reverse switch* which allow correct adjustment of the phase of the blanking with respect to the frequency deviation of the sweep.
6. A *horizontal phase control* which performs the same function in relation to the horizontal deflection voltage output to the scope.
7. A "coarse" and a "fine" *bandwidth control* that govern the frequency deviation of the sweep.
8. A *center frequency control* that sets the center frequency of the sweep and a *fine center frequency control* that allows for small variations around this value.
9. A *marker amplitude control* that controls the gain of the marker channel, and thus the height of the mark on the scope in relation to the main display.
10. A three-position *detector switch*, marked OFF, ON, and FILTER: In OFF position, the rectified output of the built-in detector is connected

directly to the "Scope V" output terminals. In ON position, the detector output is amplified approximately 100 times, the amplifier output being connected to the "Scope V" terminals. The amplifier is AC coupled, with adequate response to avoid distortion of the pattern. In FILTER position, the frequency response of the amplifier is modified to provide a high-pass response starting at about 1,000 cycles. This is useful in tests involving delay lines used for impedance measurement.

CONNECTORS

The following connectors are provided on the front panel:

1. *UHF output* - the output of the sweep when used in the 250 to 1,000 mc range. (Frequency switch in UHF position.)
2. *VHF output* - the output of the sweep when used in the 0 to 250 mc range. (Frequency switch in VHF position.)
3. *Marker #1 and Marker #2*. Either or both connectors may be used to introduce signals for frequency marking.
4. *Detector IN and OUT*. A built-in detector bridges across a transmission line having the impedance for which the sweep is designed. (Normally 75 ohms, but 50 ohms may be specified on special order.) A line termination is usually connected to the OUT connector.

5. *Ext. Det.* When a detector other than the one provided in the sweep is used, its rectified output may be plugged into this jack. This allows use of the scope preamplifier and marker injection features with an external detector.
6. *Scope V and H.* These connect the detector or preamplifier output to the scope's vertical input terminals, and the horizontal deflection voltage to the scope's horizontal input terminals.

On Back of Chassis:

In addition to the receptacle for auxiliary equipment, a switch and a connector are provided on the rear of the chassis. (See Figure 2).

1. The *horizontal phase reverse switch* allows selecting the phase relation between frequency

INITIAL SET-UP AND CHECK OF MODEL 900 OPERATION

1. Interconnect equipment as diagrammed in Figure 3. Use coaxial cable with appropriate connectors for RF connections; use shielded leads for scope connections.
2. (a) Plug into AC power. (b) Turn power switches ON. (c) Turn BLANKING switch OFF. (d) Set MARKER AMP to min. (ccw). (e) Set AGC control to max. (clockwise). (f) Turn DET. SWITCH to OFF.
3. Adjust scope controls for a full-size pattern centered on the screen similar to that shown in Figure 4.



FIGURE 2. Model 900 (Rear View)

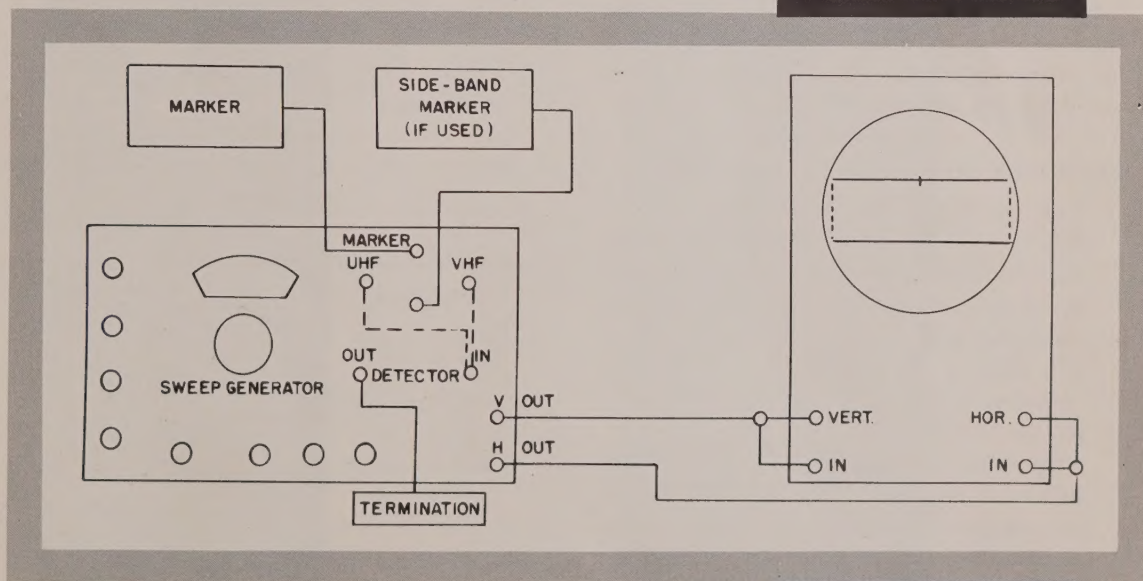


FIGURE 3. Basic Set-up of Equipment

deviation and horizontal deflection. This is normally set so that low frequencies are displayed to the left. Once set for a given scope, it needs no further attention.

2. The *blanking output connector* provides a high level square wave derived from the blanking circuits; this may be connected to the Z INPUT terminals on the scope to blank-off the beam during the return trace.

FIGURE 4



4. Turn **MARKER AMP** control part way up; set marker oscillator for full output; and select a frequency in the band to be swept. As the sweep **CENTER FREQUENCY** dial is turned past this frequency, the marker pip will show on the scope trace. In general, it will show at two points as illustrated in Figure 5.
5. Adjust *H Phase* to bring the two traces (and pips) together (Figure 6). Check sweep width by changing marker frequency so pips move from one end of trace to the other. Set *Sweep Width* control so that sweep covers the desired band. When large changes in sweep width are made, it will be necessary to readjust the *H Phase* to keep traces together.
6. Throw *H Phase* switch on rear of chassis to the position that puts the low-frequency end of the band on the left-hand side of the screen (as checked by moving marker to low-frequency end).
7. Turn **AGC** control down until output becomes flattened across the entire band (Figure 7). Leave it here for future tests. *To obtain lower output voltages, use an attenuator, i.e. Jerrold Model A-72.*
8. If a single trace with zero output base-line is wanted, throw *Blanking Switch* on (Figure 8) and adjust *Blanking Phase* (see Figure 9). Forward trace or return trace will be blanked, depending on position of *Blanking Phase Switch*; in general, either may be used.

9 CONDITIONS THAT MAY BE ENCOUNTERED

- a. *Hum* (See Figures 10, 12, and 13)
Hum in the scope or detector used in conjunction with the 900 will make it impossible to bring the two traces together (Step 5).
- b. *Poor low frequency response* in the scope will cause a tilted pattern when blanking is turned on, (see Figure 11).
- c. *Excessive Marker*
After initial check, turn *Marker Amp.* down to lowest level that will give clearly visible pip; otherwise, it may obscure details in the response curves.
- d. *Impedance Mismatch*
Variations from complete flatness when output control is turned down may be due to using the wrong impedance in the cable connecting the output of the sweep to the detector, or to the wrong terminating resistor on the other terminal of the detector.

10 THE EFFECTIVE USE OF THE MARKER CIRCUITS

The Model 900 is provided with extremely flexible marker circuits. Effective use of these will

permit accurate marking of the frequency at any point on the presentation. If excessive marker input or marker gain is used, the trace may be obscured and there may be considerable confusion in determining the correct mark to be used. Since both the output control on the marker oscillator and the marker amplitude control on the Model 900 affect the height of the pip that is produced on the scope trace, it is important to learn the proper way of arriving at a balance between the two. In general, increasing the input from the marker oscillator and decreasing the marker amplitude by turning down the marker amplitude control will result in distortion in the marker circuit. As a result, frequency marker pips will be produced, not only at the point where the sweep frequency coincides with the setting of the marker oscillator, but also at harmonics of this frequency, (as seen in Figure 14). This is not necessarily undesirable. In some cases, it may be convenient to use a marker oscillator in this fashion. Suppose, for example, that frequency marks are wanted at frequencies of 15, 30 and 45 mc. The use of a single

FIGURE 5

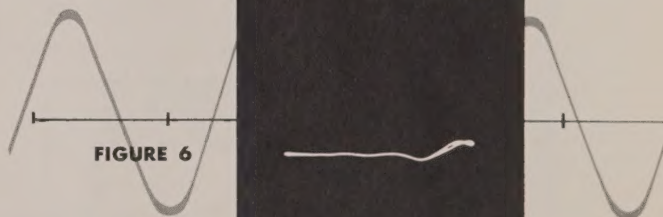


FIGURE 6

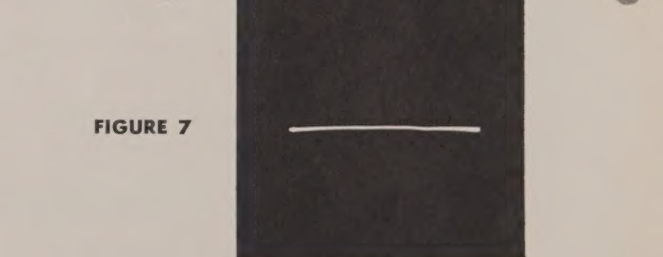
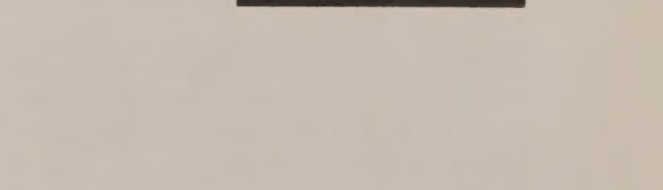


FIGURE 7



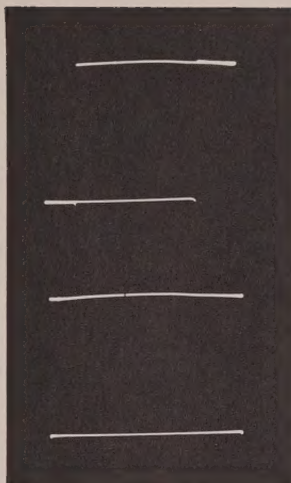


FIGURE 8

FIGURE 9

marker oscillator set at 15 mc. with its output turned well up, and the marker amplitude control turned down to give a small pip on the trace, will result in three marker pips, one at the fundamental, one at the second harmonic, and one at the third harmonic of the marker frequency. If, on the other hand, a single frequency mark is desired at the point on the trace corresponding to the fundamental frequency setting of the marker oscillator, this can best be obtained by turning the marker amplitude well up and reducing the input from the marker oscillator. This is illustrated in Figure 15.

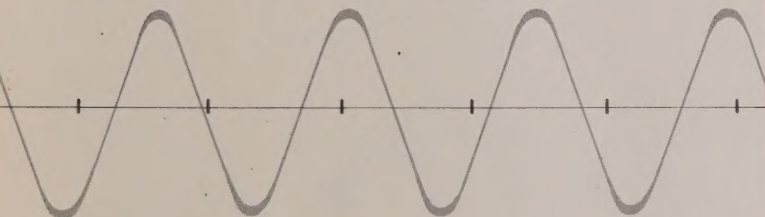


FIGURE 10

FIGURE 11

FIGURE 12

The marker amplitude control operates over a very wide range so that clear marking signals can be made to show with a wide variety of scope gain settings.

When a high gain oscilloscope is being used, too high a setting of the marker amplitude control should be avoided. In this situation, it is possible for the marker circuits to produce noise which tends to broaden and confuse the oscilloscope trace or to introduce spurious frequency marks.

It will be noted, for example, that, when using high marker amplitude settings with a high gain scope, marker pips will appear at a number of frequencies near the upper VHF limit of the sweep.

Explanation: In order to obtain the extremely-wide frequency band provided in the VHF position

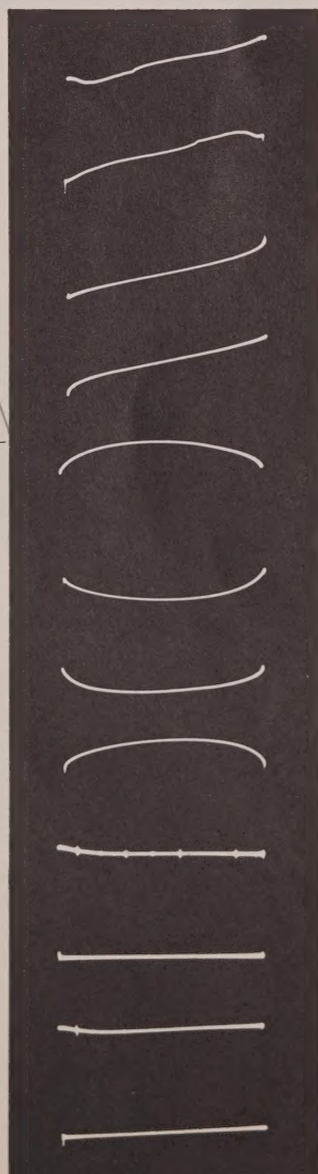
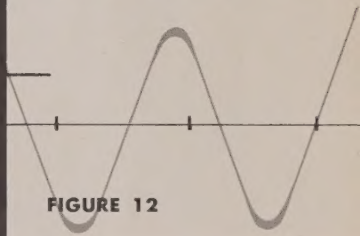


FIGURE 13

FIGURE 14

FIGURE 15



of the Model 900, the beat frequency principle is used. An oscillator inside the sweep is fixed at a frequency of 500 mc.

As a result of the mechanics of mixing, there are weak spurious signals at frequencies which are integral sub-multiples of this frequency. The largest of these occurs at the upper limit of the VHF range of the sweep at 250 mc. There is a weaker one at $1/3$ of 500 mc or 167 mc and an extremely weak one at $1/4$ of 500 mc or 125 mc. In normal operation, with reasonably low gain settings in the marker channel, these spurious pips are very small and should cause no trouble.

The Use of Side Band Markers

In cases where a bandpass response is to be observed, it is often convenient to provide frequency markers at the center, the upper and the lower frequency limits of the desired band. This can be accomplished with the Model 900 by using two marker oscillators, one having a frequency equal to the center of the band to be observed, the output of this marker being connected to one of the two marker inputs, and a second marker generator having a frequency equal to one-half of the bandwidth of the band to be observed, connected to the other marker

observed are high enough to provide adequate deflection on the scope, it is preferable to leave the detector-amplifier switch of the Model 900 in the OFF position. In this position, the internal detector or, alternatively, an external detector which is plugged into the panel jack provided for the purpose, is directly coupled to the oscilloscope's vertical input terminals. With a scope having a vertical deflection sensitivity in the order of 10 to 50 mv-inch, adequate deflection will be obtained with detector output signals of 50 mv or more.

When weaker signals are to be observed, a gain of about one hundred times, (100X) can be obtained by turning the detector switch to the ON position. Figure 18 illustrates the effect obtained using a Dumont 304A scope at $1/10$ maximum gain when connecting the output of the sweep to the built-in detector with no attenuator. With this connection, the OFF position of the detector switch gives adequate deflection on the scope.

Figure 19 shows the deflection with a 20 db pad between the sweep output and detector, and with maximum scope gain. This amount of deflection is not generally enough so the scope preamp should be



FIGURE 16

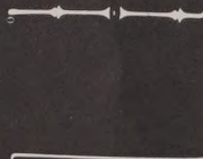


FIGURE 17

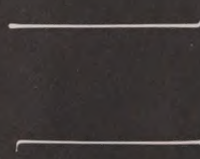


FIGURE 18

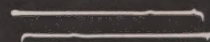


FIGURE 19

input jack. By proper setting of the two oscillator output controls and the marker amplitude adjustment on the sweep, it is possible to get three marker pips at the center frequency and at the upper and lower limits. Figure 16 shows the output of the sweep set at 60 mc with about 4 mc sweep width and a single marker at 60 mc. Figure 17 illustrates the effect of adding a second marker oscillator tuned to 1.5 mc, thereby adding sideband markers 1.5 mc above and below 60 mc.

THE USE OF THE SCOPE PREAMPLIFIER IN THE MODEL 900 (Refer to Figure 36)

When the voltage levels of the sweep signal to be

used. Figure 20 shows the effect of turning the preamp on and reducing the scope gain. Figure 21 shows the trace with 40 db attenuation and maximum scope gain. By the time the scope gain is turned up sufficiently to view the pattern resulting with 40 db of attenuation following the sweep output, a considerable amount of noise is introduced by the scope preamplifier. This is unavoidable and represents the lower limit below which effective observation of the sweep voltage cannot be made.

The third or "FILTER" position of the detector switch is used primarily with a delay line for making impedance measurements and its use will be discussed under Section F of Circuit Description.

TYPICAL APPLICATIONS

Note: When the manufacturer's instructions are available for aligning a receiver, best results will be obtained by following them carefully.

1 TESTING THE COMPLETE RECEIVER (See Figure 22)

- Connect the VHF or UHF output (depending on frequency range of receiver) to the receiver input terminals through an attenuator (i.e. Jerrold Model A-72 shown on REAR cover) and an appropriate balun, dummy antenna or matching pad (when the receiver is designed to work from an impedance other than that of the sweep and attenuator.)
- To obtain normal injection of marker signals, connect output of receiver's second detector to EXT. DET. jack on Model 900 as shown on diagram. Set DET switch in OFF position
- If the receiver uses AGC, disable it and substitute manually-variable gain control.
- Use weak input signal and high scope gain to avoid overload (to test for overload, decrease input signal 5 or 10 db; if response shape changes, overload is present).
- Set sweep and receiver to same center frequency, and sweep width just wide enough to show the entire response curve. Note that weak responses will be seen when the

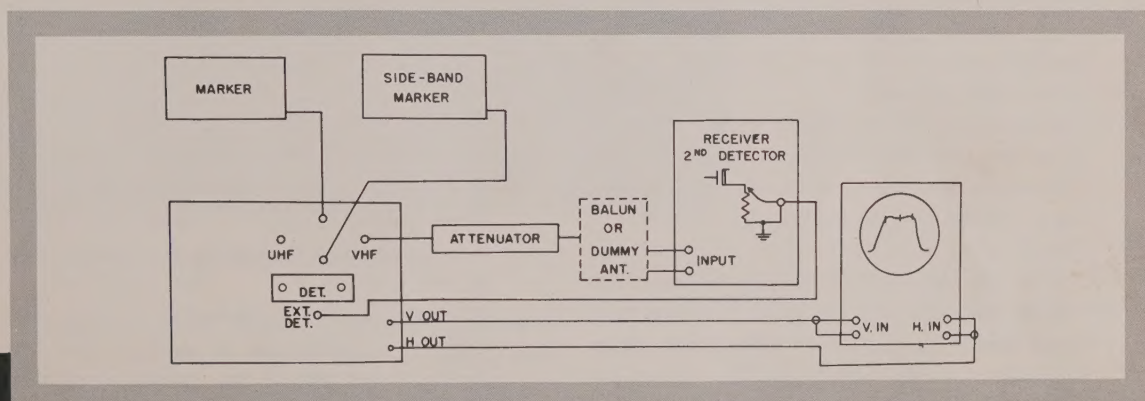


FIGURE 22. Block Diagram of Equipment Set-up for Testing a Complete Receiver

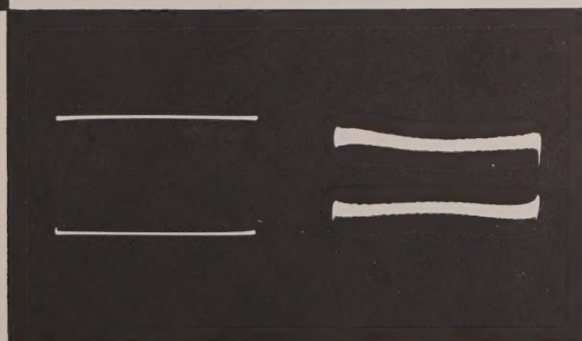


FIGURE 20

FIGURE 21

since detector output is high and this maintains DC coupling to scope. Alternatively, the detector can be connected directly to scope input, the output of the marker generator being loosely-coupled to the input of the receiver to obtain markers. In this case, the size of the marker will change as receiver gain changes so that constant readjustment of marker coupling will be required.

- If the receiver uses AGC, disable it and substitute manually-variable gain control.
- Use weak input signal and high scope gain to avoid overload (to test for overload, decrease input signal 5 or 10 db; if response shape changes, overload is present).
- Set sweep and receiver to same center frequency, and sweep width just wide enough to show the entire response curve. Note that weak responses will be seen when the

- receiver is tuned to a harmonic of the sweep, or when the sweep is at the image frequency of the receiver. If there is doubt, the strongest response is probably the right one.
- For band-center and band-edge markers, set marker generator at center frequency and side-band marker at a frequency equal to $1/2$ the bandwidth of the receiver. Where pix and sound carrier markers are wanted (on a television receiver), set marker generator at pix carrier, side-band marker at 4.5 mc.
- When there are sudden changes in the response of the receiver (as, for example, when very selective traps are used to remove certain frequencies, the sweep may move past these too fast for the second detector to follow accurately. To get a more accurate response, decrease the sweep width and shift center-frequency to cover only this section of the response.

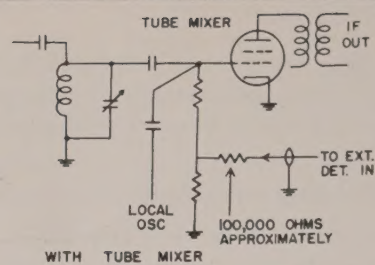
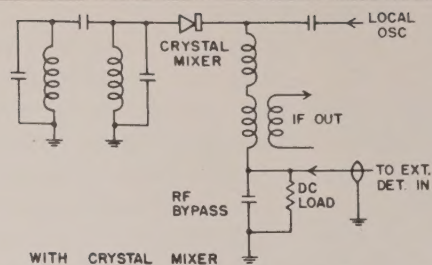


FIGURE 23. Schematic Diagram of Scope Connections to Test the RF Section of a Receiver

2 TESTING THE RF SECTION OF A RECEIVER

- Connect Model 900 output to receiver input terminals as when testing complete receiver.
- Connect scope vertical input to the DC load of the mixer (see Figure 23). This connection is often provided as a test point by the manufacturer. It may be necessary to turn DET switch to ON position to get enough gain.
- Use high-level input with only enough attenuation to ensure a good impedance match (6 to 10 db is enough).
- Distortion of the response curve, preventing matching of forward and return trace, can be caused by hum due either to the local oscillator (which can be temporarily disabled to check this) or to the method of connecting the scope vertical input. In general, this test should be made with the local oscillator running since its excitation affects the input impedance of the mixer, and thus the shape of the RF response curve.

3 TESTING THE IF SECTION OF A RECEIVER

- Connect the second detector output to EXT. DET. jack as when testing the complete receiver, with DET. switch OFF.
- The output of the sweep should be introduced into the mixer circuit in some way that will give reasonably uniform response without changing the output impedance of the mixer. One way of doing this is shown in Figure 24. The output of the sweep is connected to a terminating resistor near the output terminal of the mixer, and is coupled to the mixer output loosely enough to avoid changing the tuning of the mixer output circuit.
- It is important to introduce the IF signal from the sweep in a way that does not result in added overall feed-back in the IF circuits. The outer shield of the cable from the sweep should be carefully grounded to the chassis near the mixer. With IF's above 10 mc or so, it is preferable to attach the cable with a connector which brings it through the chassis. The presence of this type of feedback is in-

dicated if the IF response curve differs markedly from the overall curve (with the usual broadly-tuned RF circuits).

4 TESTING THE FREQUENCY RESPONSE OF AMPLIFIER WITH MODEL 900 (See Figure 25)

- When testing an amplifier, the output of the sweep is connected to the amplifier through a variable attenuator to reduce the level. When the source impedance from which the amplifier is designed to operate differs from sweep's output impedance, a matching pad is required.
- The amplifier output is connected to the input of the sweep's built-in detector, through a second matching pad if its normal load differs from the sweep's impedance. (Use DET switch in OFF position.)
- When the amplifier bandwidth is extremely wide, one marker can be used to mark the low-frequency end of the response, another being used for the high end. For example; if markers were wanted when testing a distributed amplifier having response from 2 to 200 mc, a low frequency signal generator connected to the #1 marker input could mark the 2 mc end, while a high frequency generator connected to the #2 marker input could mark the 200 mc end.
- For narrower bandwidth, the center-frequency marker plus the side-band marker is more convenient. For example, a 54-88 mc amplifier response curve could be marked with a 71 mc marker, with 17 mc side-bands.
- To measure the amplifier's gain, use blanking to establish a base line. Note height of curve H_1 on diagram and attenuator setting. Now remove amplifier and connect output of M1 (or attenuator, if no matching pad is used) to input of M2 (or detector if no matching pad is used). Find attenuator setting required to make "feed-thru" height H_2 equal to curve height H_1 . The amplifier's gain is the amount of attenuation removed from the circuit to make the two heights equal.

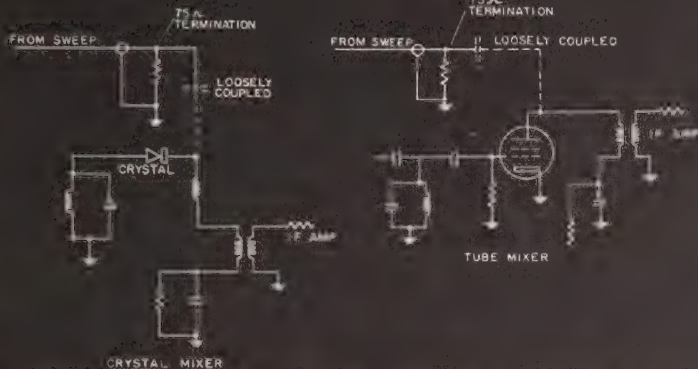


FIGURE 24

Schematic Diagram of Input Connection to Test the IF Section of a Receiver.

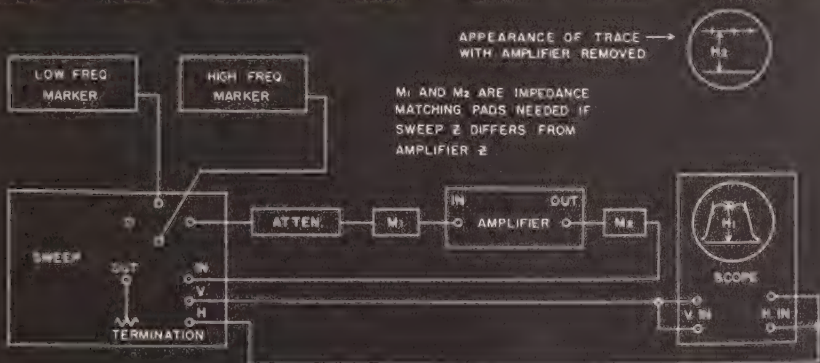


FIGURE 25

Block Diagram of Equipment Set-up to Test Frequency Response of an Amplifier.

5 TESTING FILTERS AND TRANSFORMERS (See Figure 26)

- When testing filters, transformers, or other passive circuit elements with the Model 900, the loss of the unit being tested will frequently reduce the output voltage to the point where the OFF position does not give enough deflection.
- The use of the built-in preamplifier (ON position of DET switch) allows testing with much weaker signals. If still more gain is needed, follow the unit being tested with an amplifier having a wider pass-band. This will increase the level sufficiently to make the curve visible.
- The response curve of this second amplifier should either be extremely flat, or should be taken into account in judging the result. A quick way to accomplish the latter is to substitute, for the matching pads and the unit under test, a variable attenuator permitting inspection of the response curve alone.
- Unless the input impedance of the amplifier is well-matched, the loss of the second matching pad (M2) should be great enough so that its input impedance is unaffected by the amplifier's mismatch.
- To determine the loss at a given point on the filter's response curve, use the blanking to

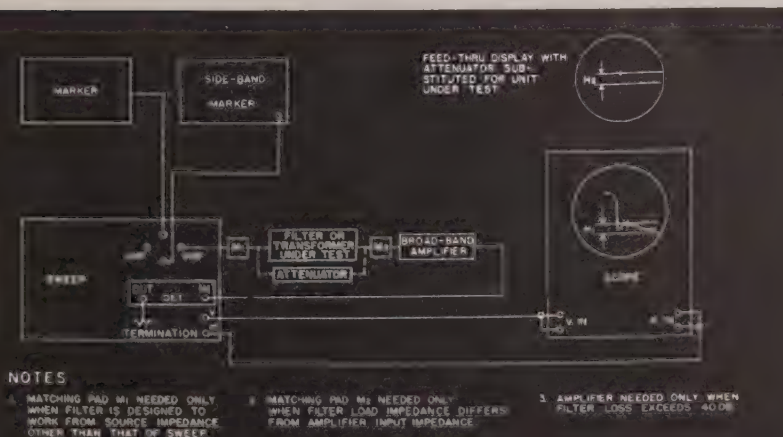


FIGURE 26

Block Diagram of Equipment Set-up to Test Filters or Transformers.

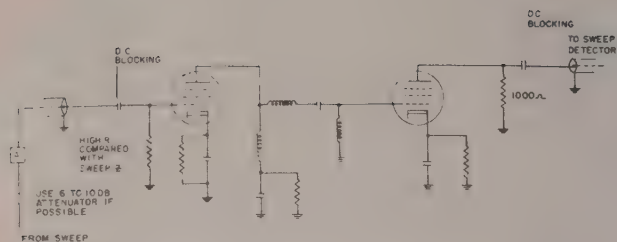


FIGURE 27. METHOD 1: Schematic Diagram of Connections to Test Frequency Response of an Interstage.

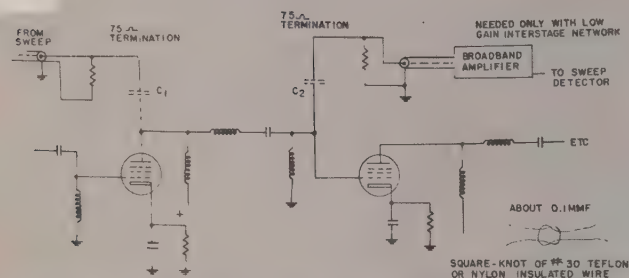


FIGURE 28. METHOD 2: Schematic Diagram of Connections to Test Frequency Response of an Interstage.

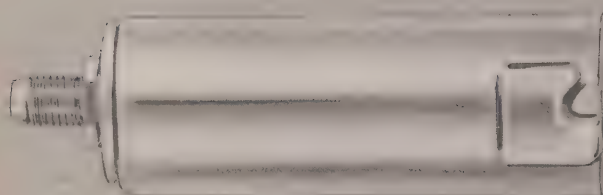


FIGURE 29. Photo of a "Jig Shield", Jerrold Model AJ-106

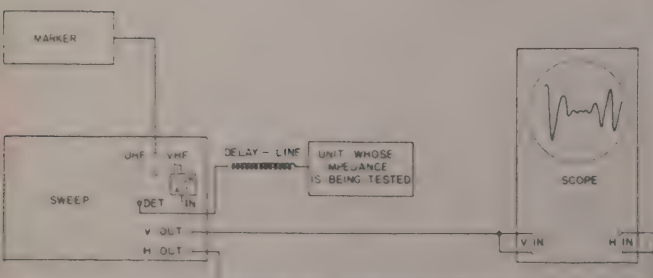


FIGURE 30. Block Diagram of Equipment Set-up to Test Impedance with a Delay Line

provide a zero base-line. Measure the distance, H_1 , on the scope screen from the base-line to the point at which the loss is desired. Now substitute a variable attenuator for the unit under test (dashed lines) and, adjust it until the height of the "feed-thru", H_2 , is the same as H_1 . The attenuator setting is now equal to the loss of the filter at the desired point on the curve.

6 TESTING A SINGLE INTERSTAGE IN AN AMPLIFIER

In development work, or in receiver testing, it's sometimes useful to be able to sweep the frequency response of a single amplifier interstage. To accomplish this, it is necessary to introduce the signal from the sweep and to take off the output in some way that does not materially affect the response of the interstage.

Method 1 (See Figure 27)

One way to accomplish this, assuring good sensitivity and requiring no auxiliary amplifier, is illustrated in Figure 27. The RF signal from the sweep is connected directly to the grid of the tube preceding the circuit to be tested, with minimum length connections. With no termination at the grid, this connection gives an input voltage which is constant out to about 200 mc (with 10 mmf input C, 75 ohm sweep, and minimum lead inductance). A small (6 to 10 db) attenuator pad inserted in the cable from the sweep will, in general, improve the accuracy of the response. A similar connection at the plate of the second tube gives an output voltage proportional to its grid voltage over a similar range.

For critical work, the effect of the coupling capacitors, bypass capacitors, and connections can be checked by connecting to the plate of the first tube in the same way as shown for the second and observing any variation in the response of this much of the circuit.

Method 2

For some purposes a disadvantage of Method 1 is that the observed response does not include any effects due to feed-back around either of the two tubes, or from other stages in the amplifier. A second method gets around this difficulty, by the addition of an auxiliary amplifier whose response is flat beyond the response of the stage being tested.

The connections are diagrammed in Figure 28. The coupling capacitors C_1 and C_2 must be small enough to have negligible effect on the capacity and loading at these points, but large

enough to give a response curve. One technique that gives a capacity in the order of 0.1 mmf, is to tie a square knot between two pieces of #30 wire having low-loss insulation like Teflon or nylon.

NOTE: Any method of coupling signals in or out that depends on capacity coupling can be used only with narrow-band amplifiers (10% of center-frequency or less). In wider band amplifiers, the change of coupling with frequency introduces a deceptive tilt to the response curve.

With this connection, the effects of feed-back can be quickly checked. Varying the gain of the first tube, or shorting its grid circuit, will show whether there is any feed-back to earlier sections of the amplifier. Varying the gain of the second tube, or shorting its plate circuit, will show whether there is feed-back from later sections of the amplifier. When tubes with unshielded plates, like 6AK5 or 6CB6 are used, a convenient way to introduce a test signal into a plate circuit is to use a "jig shield" such as Jerrold Model AJ-106, which substitutes for the tube shield and couples a signal into the plate (see Figure 29).

7 IMPEDANCE TESTING WITH A DELAY LINE

One of the most useful applications of a sweep is the testing of impedances to determine the degree to which they match a transmission line. Figure 30 illustrates the connections. A 10 db pad is required between the sweep output and the diode detector since the impedance presented to the sweep by the input end of a mismatched delay line varies so rapidly and over such extreme values, as to make proper AGC action difficult.

Figures 31 to 34 inclusive show typical patterns obtained with this technique. With the sweep covering the 50 mc - 100mc range and a thirty-three foot section of RG-11/U serving as the delay line an open circuit at the end of the line gives maximum ripple height as shown in Figure 31. Short-circuiting pattern, Figure 32. A broad band termination gives a minimum ripple across the band, Figure 33. The degree of match is indicated by the ripple height at each frequency. Adjustments made to minimize ripple height will result in best match at the corresponding frequencies. Figure 34 shows the pattern with a load that matches only over a 6 mc section of the band being swept. The spacing between adjacent peaks in the ripple pattern is determined by the length of the delay line; long lines having closely-spaced ripples are most useful for testing narrow-band cir-

cuits. The spacing between peaks in megacycles can be calculated from the following:

$$f = \frac{333}{\text{length in feet}} \quad f = \frac{492}{\text{length in feet}}$$

for solid polyethylene cables. for air dielectric cables. The height of the ripple pattern, for a given degree of mismatch, is determined by the total attenuation of the cable. When very long delay lines are used to test narrow-band circuits they must be made from low-loss cable.

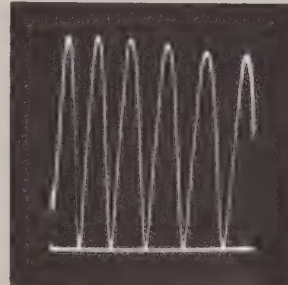


FIGURE 31

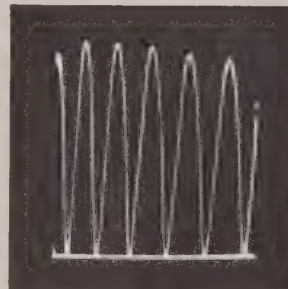


FIGURE 32

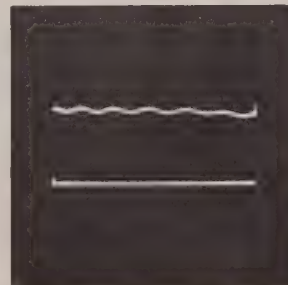


FIGURE 33



FIGURE 34

Circuit Description

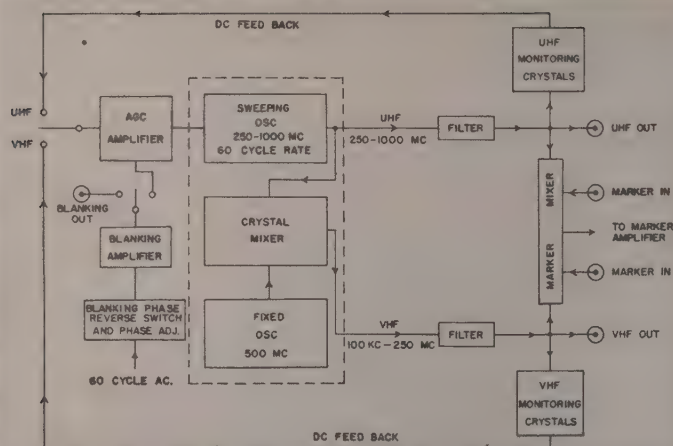


FIGURE 35. Block Diagram of the AGC and RF Section

The block diagrams in Figures 35 and 36 may be referred to throughout this circuit description, while schematic details are reproduced wherever they serve to clarify the explanation.

THE UHF SWEEP OSCILLATOR

The heart of the Jerrold Model 900 is the UHF sweep oscillator, diagrammed in Figure 37. A section of air-dielectric coaxial line forms the inductance in the oscillator's tuned circuit. Its inductance is varied by a short-circuiting plunger whose position is controlled by the setting of the center-frequency control on the front panel. This governs the effective length of the line and, thus, the center-frequency of the oscillator which can be varied from below 275 mc to above 1000mc. The line is carefully machined out of rugged brass stock and is Rhodium plated internally to ensure long and trouble-free operation. The shorting plunger is of unique design, providing uniform contact and a minimum of residual inductance. The capacity across this line, and thus the frequency of the oscillator, is varied at a 60-cycle rate by a wobblator capacitor driven by a precision voice coil mechanism. Since this capacitor has two stators meshing with the moving capacitor plates, it needs no pigtail connection to the moving plates. Thus, there is no maintenance problem associated with a vibrating connecting strip. The pencil triode oscillator tube is used in a grounded grid circuit in which the plate is connected to the high end of the resonant circuit. The grid is connected to chassis through a grid capacitor and the cathode

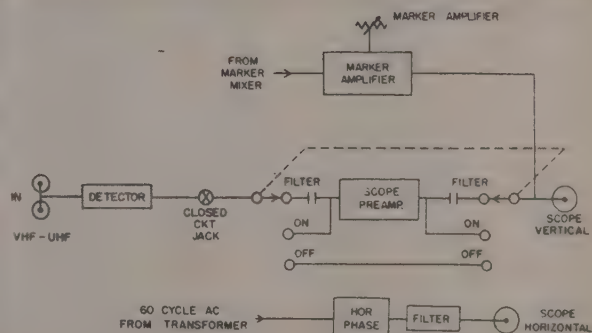


FIGURE 36. Block Diagram of the Detector, Preamp, and Marker Amp Section

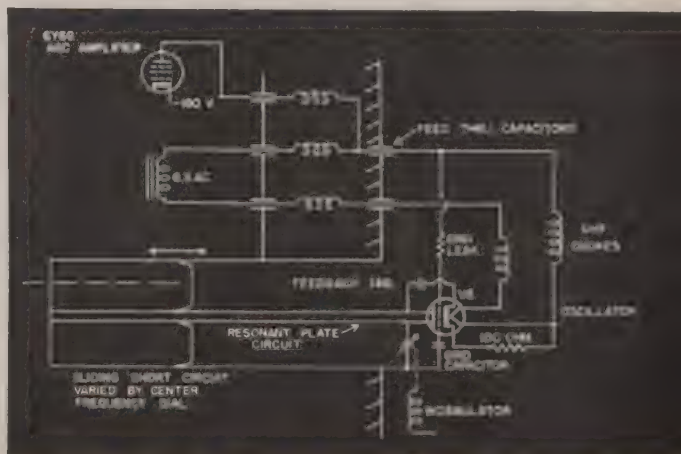


FIGURE 37. Schematic Diagram of UHF Sweep Oscillator

is floated above ground on UHF chokes that provide a high impedance path from cathode to ground over the entire frequency range of the oscillator. A small feed-back capacitor is provided between plate and cathode to provide ample feed-back coupling over the frequency range.

The plate of the oscillator is grounded to the chassis for DC. The cathode is connected to the negative power supply (-160 volts) through a 6Y6G, AGC amplifier. Varying the grid voltage of the 6Y6G varies the oscillator DC current, and thus its output, permitting AGC of the unit. Supply leads are carefully by-passed where they come through the wall of the oscillator compartment and are doubly-filtered to prevent any possibility of radiation from this source.

THE UHF OUTPUT CIRCUIT

Figure 38 shows a diagram of the UHF output circuit of the Model 900. A small trimmer loosely couples the output to the oscillator cathode. The two capacitors, C48 and C49, and the two inductors, L9 and L10, form a low-pass filter, cutting off slightly above the high-frequency end of the oscillator's output range. These have the effect of minimizing harmonics in the output voltage which would make effective AGC Action impossible and cause difficulties in applications of the sweep.

At the output of the low-pass filter, two AGC diodes (the UHF Monitoring Crystals) are connected in a voltage-doubling circuit providing voltage information to operate the AGC circuit. The effect of the AGC operation is to hold the

voltage at this point constant, regardless of variations in the output of the oscillator or in the load connected to the UHF output.

Since the voltage at this point is held constant by the AGC circuit, the effective impedance seen looking back towards this point is extremely low, and a close match to any desired source impedance can be obtained by simply inserting the corresponding resistance "R" between this point and the UHF output connection.

THE VHF CIRCUITS

A diagram of the VHF circuits is shown in Figure 39. The VHF output voltage is obtained by beating the output of the UHF sweep oscillator with that from a fixed oscillator which is tuned to 500 mc. When the frequency of the UHF oscillator is varied from 500 mc. up to 750 mc., the beat frequency correspondingly changes from 0 to 250 mc. The fixed oscillator uses a balanced-type of tuned circuit between plate and grid, with the cathode and heater floating above ground on RF chokes.

The output from this oscillator is loosely-coupled to a balanced circuit resonated to the fixed oscillator frequency by C63 and C64 and connected in "push-pull" to the two mixer diodes. These diodes are mounted in a shield partition between the fixed oscillator and the sweep oscillator. This shielding, and the use of balanced coupling to the fixed oscillator and unbalanced coupling to the sweep oscillator minimizes direct coupling between the oscillators. This makes it possible to obtain low beat frequencies (200 kc or less) before lock-in occurs. Careful adjustment of the

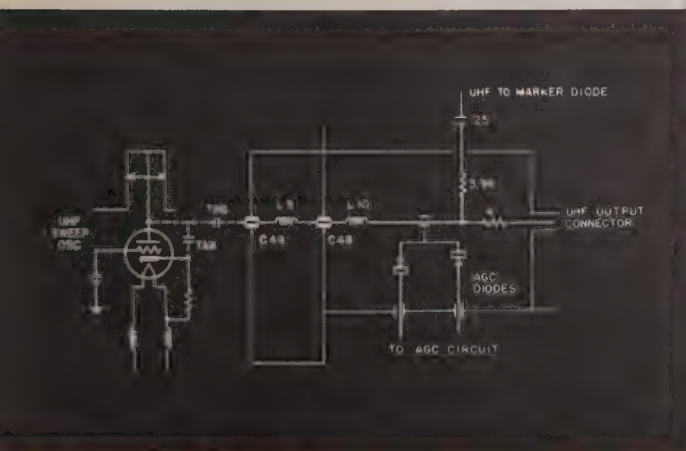


FIGURE 38. Schematic Diagram of UHF Output Circuit

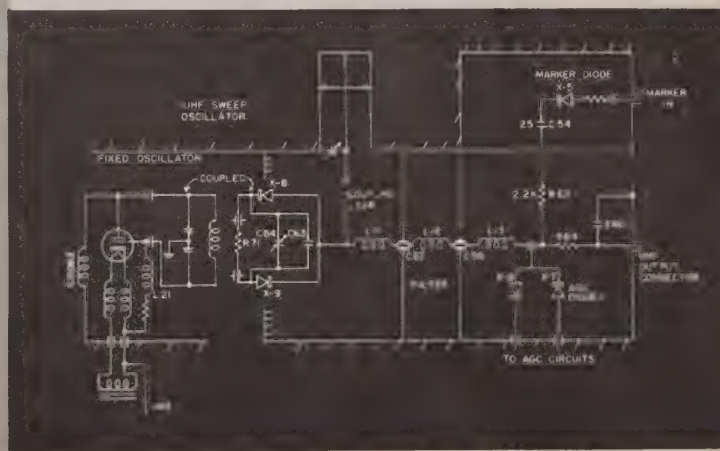
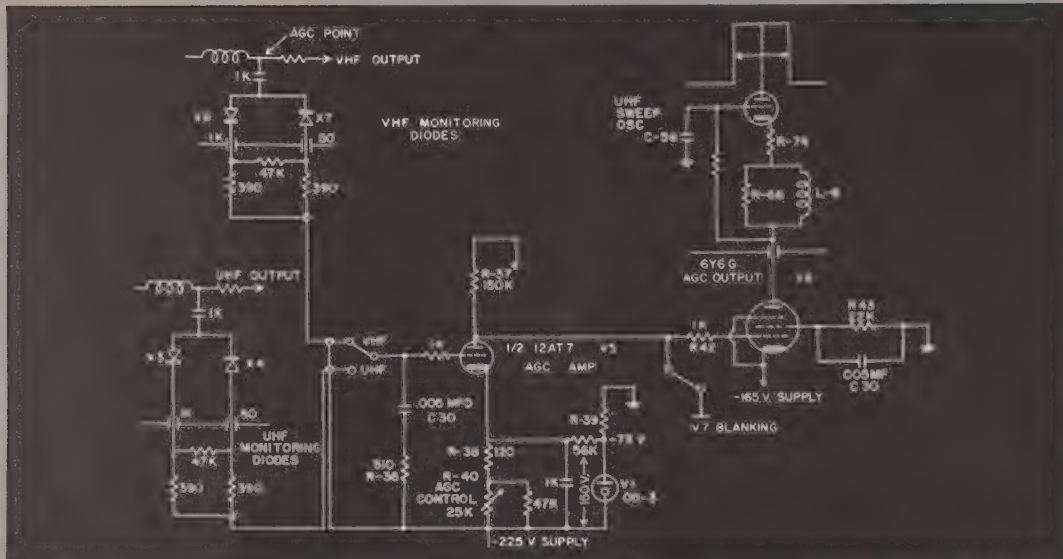


FIGURE 39. Schematic Diagram of VHF Circuits

FIGURE 40. Schematic Diagram of AGC Circuits



coupling between the fixed oscillator and the crystals is required to maintain optimum use of this feature.

A bias resistor (R71) in the mixer diode circuit provides the optimum operating point for the mixer crystals. The beat frequency output of the mixer diodes is conducted through a low-pass filter consisting of the three inductors, L11, L12 and L13, and the two capacitors, C56 and C57. This filter cuts off slightly above 250mc and has the double function of eliminating any UHF components, and, at the same time, minimizing harmonics in the VHF output voltage.

Two AGC diodes (VHF Monitoring Crystals) in a voltage-doubling circuit are connected at the output end of the VHF filter and act, together with the AGC circuits, to hold the voltage at this point essentially constant throughout the frequency range of the sweep oscillator.

A matched source impedance, looking back from the VHF output connector, is obtained by inserting a suitable resistor, R64, at this point, a small amount of residual inductance being corrected by C60 connected across the output. Some of the VHF sweep signal at the AGC point is coupled to the marker diode by a 2200 ohm resistor and 25 mmfd capacitor in series (R63 and C54).

THE AGC CIRCUITS

Figure 40 shows a diagram of the AGC circuits. The VHF monitoring diodes, X6 and X7, form a

The gain of the AGC amplifier is made as high as possible, limited by a tendency to break into audio-frequency oscillation at low output settings. C30 and R36, shunted across the output of the monitoring diodes, minimize this tendency to oscillate and increase the allowable AGC gain. The output voltage at which the system stabilizes is determined by the delay bias applied to the cathode of the AGC amplifier, V5. This voltage is controlled by the AGC control R40, which varies the resistance in the lower half of a bleeder circuit. The voltage applied to this bleeder is regulated by a gas tube V1 so that the reference voltage for the AGC, and thus the output voltage

THE BLANKING CIRCUIT

Since the frequency is swept at a 60 cycle rate, the blanking circuit requires a 60 cycle drive. This is obtained from the secondary of the power transformer through shaping and phase-shifting circuits as shown on the diagram. The resulting 60 cycle sine-wave voltage is applied to the grid of the first half of V7 through a 1.8 meg. series resistor (R49) and positive grid limiting flattens its top. This triode is cut off on the negative swing of the grid voltage so its plate voltage is a 60 cycle square-wave. This is applied to the grid of the second section making its plate current alternate at 60 cycles between zero and a constant value.

When the blanking switch is ON, the plate of the second section of V7 is connected to the grid of the AGC output tube (V5). During the half-cycles when V7B is cut-off, the AGC system works normally; during the half-cycles when it conducts, the grid of V5 is made very negative with respect

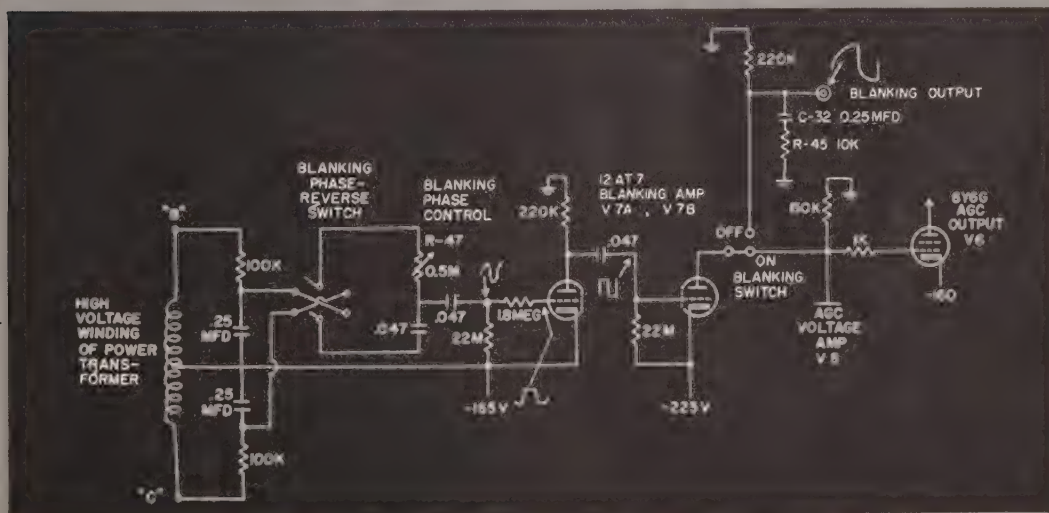


FIGURE 41. Schematic Diagram of the Blanking Circuits

to its cathode, cutting-off its plate current and reducing the output of the sweep oscillator to zero.

When the blanking switch is OFF, the square-wave plate current of V7B flows in a network connecting to the blanking output jack (J11) on the rear of the sweep chassis. C32 and R45, connected across the output, tilt the square-wave to compensate for the poor-low-frequency response of most blanking (Z axis) connections on commercial oscilloscopes. Should the response of the scope's Z axis connection be exceptionally good, one side of the unblanked trace will be appreciably brighter than the other. This sit-

Both output terminals of the detector are insulated from the chassis and connected by a shielded cable to the preamp input to avoid ground-loop hum troubles and thus allow operation at high audio frequency gain. The detector output is connected to the EXT. DET. jack in such a way that plugging in an external connection disconnects the built-in detector, and substitutes the external one. Using this input instead of connecting directly to the scope's vertical input terminals allows use of the preamplifier and marker injection circuits in the sweep in the normal way. When the DET-AMP switch (SW6) is set in the OFF position the output of the built-in detector

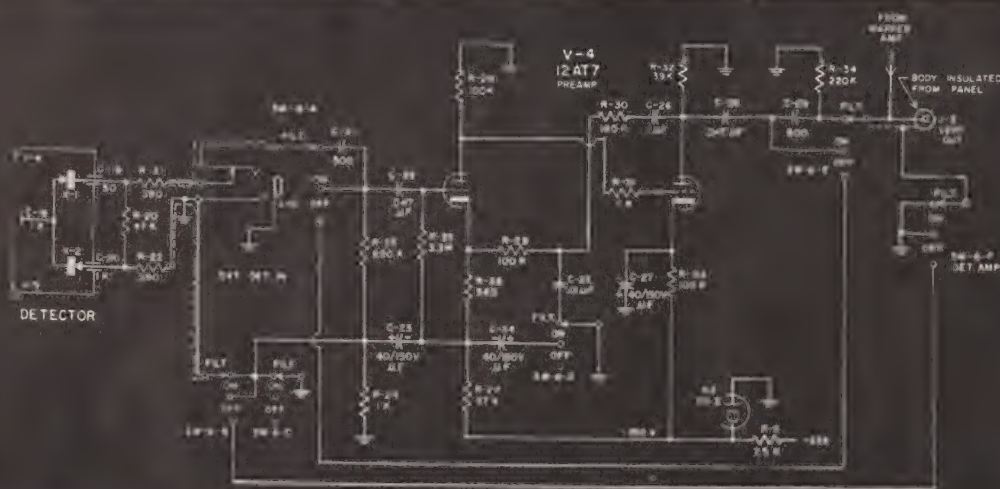


FIGURE 42. Schematic Diagram of the Scope Preamplifier and Detector Circuits

uation can be corrected by shorting out C32, or substituting a more appropriate capacity value.

THE DETECTOR AND SCOPE PREAMPLIFIER CIRCUITS

These circuits are diagrammed in Figure 42. The built-in detector in the Model 900 offers many advantages. It allows a quick check on the magnitude and flatness of the sweep output; it allows sweep measurements on passive circuit elements such as transformers and filters; and it is used with a delay line for impedance match measurements. The detector uses diodes matched in characteristics and circuit to the AGC monitoring diodes, as is necessary if the scope display is to be flat over the extreme frequency range available in this sweep. The diode load and RC filter constants are chosen to provide a good compromise between sensitivity and adequate audio-frequency response to follow rapid changes in RF frequency response. The filtering is sufficient so that only the lowest frequency components (near 100 kc) appear on the scope.

(or an external one when plugged into the jack) is connected directly to vertical output jack (J3) and thus to the scope's vertical input.

When this switch is turned to the ON position the detector output is connected to the input of the preamplifier. The two halves of a 12AT7 (V4) are used in a two stage RC-coupled amplifier to provide a gain of about 100 times. Inverse feedback is used to stabilize the gain, and to correct for the coupling networks so that the low frequency response is good enough to pass a 60 cycle square-wave (as is required to prevent distortion of response curves). The output of the preamp is connected to the vertical output jack (J3) in this switch position.

When the switch is turned to the FILTER position, the input and output coupling capacitors, as well as constants in the amplifier, are changed to give the amplifier a high-pass frequency response rejecting audio frequencies below about 1000 cycles. This response is useful when a

delay line is used for impedance measurements, and in other cases where it is desired to view responses that change rapidly with frequency, and minimize the effects of slower variations.

THE FREQUENCY MARKER CIRCUITS

To provide for accurate and convenient frequency calibration of response curves obtained with the Model 900, frequency marker injection circuits are built-in. Figure 43 shows a diagram of these circuits. A part of the UHF or the VHF output voltage (depending on which is being used) is coupled through isolating circuits R57-C50 or R63-C54 to the marker diode. In the diode, this

on the narrowest bandwidth settings. The advantage of this selectivity in the marker amplifier is that it rejects low frequency components in the output of the marker diode, due chiefly to the operation of the blanking circuit, which would otherwise cause distortion of the response curve at high marker gain settings and prevent marking with weak marker signals. The marker gain control (R17) controls the portion of V3A ac plate voltage applied to the grid of the second section V3B. This triode provides further gain and the signal is coupled from its plate circuit to the vertical output jack (J3) through a small capacitor (C16) so there is very little effect on

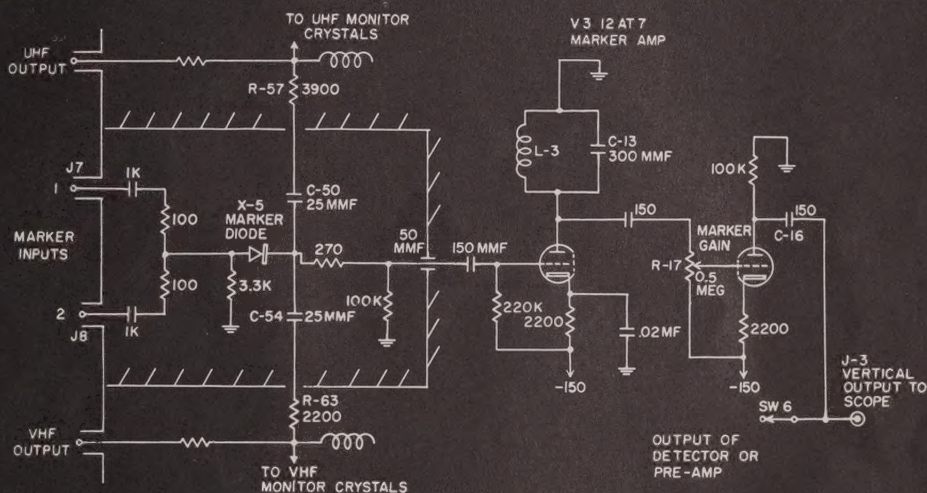


FIGURE 43. Schematic Diagram of the Frequency Marker Circuits

sweep voltage is mixed with single frequency signals from generators attached to either or both of the marker input jacks (J7 and J8). As the frequency of the sweep passes the frequency of the single-frequency signal, an audio frequency beat signal is produced in the output of the marker diode sweeping from a few hundred kc. (limited by the shunt capacities in the circuit) down through zero beat and back up again.

These beat signals are applied to the first section of V3, the marker amplifier. Its plate circuit is resonated, by L3 and C13, to a frequency of about 25 kc. This has the effect of providing a sharp peak of output as the marker beat goes through 25 kc., and rejecting all other frequencies. Since the beat goes through this frequency twice each time the sweep passes a marked frequency (once as it approaches, and again as it goes away) each frequency is marked by two closely-spaced pips. These are so close together (about 50 kc) that they appear as one pip, except

the signals coming from the detector.

WOBBULATOR AND HORIZONTAL DEFLECTION CIRCUITS

To obtain linear frequency scales on response curves obtained with the Model 900, voltages to drive the wobbulator voice coil and the horizontal deflection output should be constant level 60 cycle sine-waves. The voltage on the secondary of the Sola regulating power transformer is extremely constant, due to the regulating action of the transformer, but its wave-form is highly distorted for the same reason. Before it can be used, it must be filtered to achieve a relatively-pure sine-wave.

As shown schematically in Figure 44, the sinusoidal voltage to drive the wobbulator is obtained by connecting the primary winding of a small transformer (T2) across a part of the power transformer's secondary through a resonant filter consisting of C4, C5 and Ch2. Controls are provided at this point to allow precise setting of the volt-

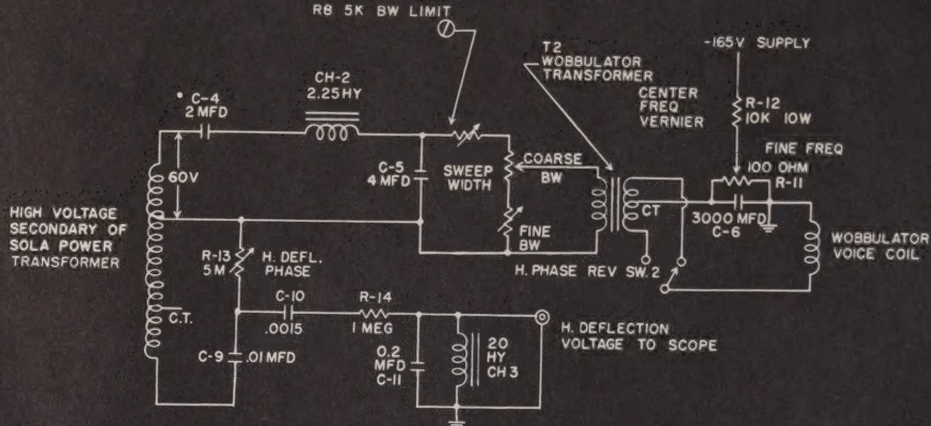


FIGURE 44. Schematic Diagram of the Wobbulator and H. Deflection Circuits

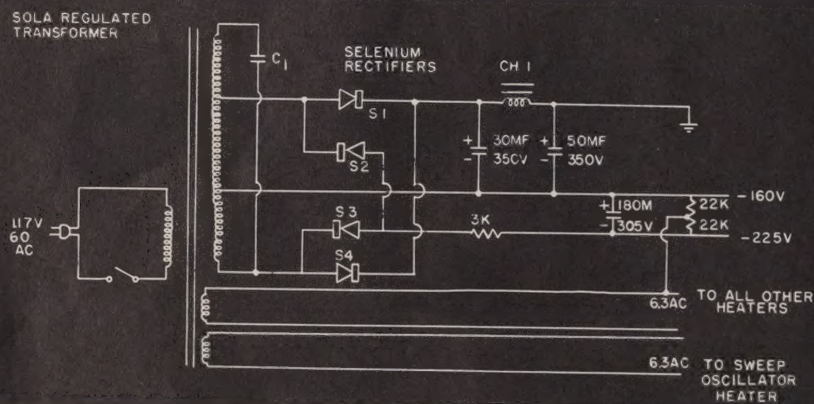


FIGURE 45. Schematic Diagram of the Power Supply

age applied to the wobbulator, and thus of the bandwidth. The secondary of T2 is center-tapped so that voltage in either phase can be selected by the PHASE REVERSE switch (SW2), allowing choice of the horizontal direction corresponding to increasing frequency. A small d-c current, controlled by the setting of R11, the FINE FREQUENCY control, is made to flow through the wobbulator voice coil, providing a small change in its rest position, and thus in the center frequency. The voltage for horizontal deflection is obtained from the high-voltage secondary of the power transformer through a phase-shifter (R13 and C9) and isolating circuit (C10 and R14). It is filtered to obtain a sinusoidal wave-form by a parallel resonant circuit (C11 and CH13) tuned to 60 cycles.

POWER SUPPLY

The power supply for the Model 900 is diagrammed in Figure 45. A Sola regulated power transformer is used so that the operation of the Model 900 is completely unaffected by line voltage variations normally encountered. The Secondary voltage from the Sola transformer is rectified by two pairs of selenium rectifiers, one pair providing a high-current well-filtered output at -160 volts for the major circuits in the sweep; the other pair providing a low current output at -225 volts for the AGC amplifier and blanking circuits. All heaters except the sweep oscillator's are connected to a tap on the supply chosen to get the lowest heater-to-cathode voltage on all of them.

ANOTHER WIDE BAND SWEEP GENERATOR WITH UNUSUAL CHARACTERISTICS

Models 95 and 220... Ideal for laboratory or field use

Features:

- All electronic — saturable reactor — sweep circuit
- Push-pull Hartley oscillator operating on fundamental frequencies
- High RF outputs — up to 1.5 volts RMS
- Flat RF outputs — ± 0.5 db (through AGC circuitry)
- Internal blanking circuit
- Horizontal output featuring 360 degree phasing
- Output VSWR less than 1.1
- Rugged portable design



Description

JERROLD Wide-Band Sweep Generators — Models 95 and 220 — are rugged, portable instruments designed for the test and alignment of radio frequency circuits in the frequency spectrum from 22 to 220 MC. The Generators contain an all electronic sweep circuit — of the saturable reactor type — with a sweep range of approximately 5 to 1. The RF output of each instrument is held constant throughout its operating range by a highly effective AGC circuit. The portability, operating stability and constancy of the output recommend these instruments for the production test line, the laboratory, the service shop and the field.

Cabinet

Both units are housed in an attractive, portable aluminum case complete with convenient carrying handle. The finish is durable baked-on "wrinkle" finish of government specifications. A hinged cover protects the front panel and knobs and also contains the calibration chart. A small compartment has been included in the cabinet to house the line cord and other accessories that may be used with the instrument.

For additional information write for
Manual #9522

Model 95

The sweep width of the Model 95, Sweep Generator, is continuously variable from 2 MC to approximately 73 MC. The instrument is particularly useful in the alignment and/or test of RF circuitry in the frequency range of 22 MC to 95 MC.

Model 220

The sweep width of the Model 220, Sweep Generator, is continuously variable from 2 MC to approximately 166 MC making it possible to sweep the entire VHF television band (54 to 216 MC) without the necessity of changing the Generator's center frequency. The instrument is invaluable for the alignment and test of RF circuitry in the frequency range of 54 MC to 220 MC.

Specifications:

Frequency Range:

Model 95: 22 to 95 MC/SEC
Model 220: 54 to 220 MC/SEC

Sweep Range: Approx. 5 to 1

RF Output Response:

Model 95:
1.5 Volts flat across a 73 MC band
Model 220:
0.7 Volts flat across a 166 MC band

Horizontal Sweep Output:

Sine voltage of 60 cps. Complete phasing over a range of 360 degrees is provided.

Blanking:

Blanking is provided, and accomplished internally.

Power Requirements:

117 Volts a-c, 60 cps at 70 watts.

Tube Complement:

V-1—6BC8—RF Sweep Oscillator
V-2—12AT7—AGC Amplifier and Control
V-3—12AT7—Blanking (limiter and clipper)
V-4—6L6—Reactor Driver
V-5—6AS5—Cathode Follower
V-6—OA-2—Negative Voltage Regulator

Dimensions:

Height: 12" — Width: 12 $\frac{3}{4}$ " — Depth: 8" —
Weight: 24 lbs.

JERROLD



Jerrold has found it necessary to design and manufacture, for its own use, many types of test equipment and other specialized components, not available on the commercial market. This necessity has led to the development and production of unusual equipment and accessories that have great benefit for the electronics industry.

Jerrold's advanced leadership and experience in the field of RF signal transportation and distribution is of valuable assistance in the office, plant, laboratory and in the field.

A few of the diversified applications for Jerrold Equipment and Services are listed below:

Television Systems

Utilizing FM modulation and demodulation equipment, Jerrold's exclusive single cable tone-controlled transmission system permits extreme accuracy in closed circuit television, data transmission, remote control and all phases of RF and video distribution over great distances.

Instrumentation

The use of Jerrold wide-band sweep frequency generators, field strength meters, oscilloscope preamplifiers, electronic coaxial switching devices, RF attenuators and other test accessories permits more accurate laboratory measurements, improved production tests and field surveys.

Communications

Parabolic and other special high-gain, directive television antennas, television transmitters, AM amplifiers, regulated power supplies and a complete line of RF amplifying and distribution equipment for the ultimate in master and community antenna systems.

Engineered Accessories

Assure low VSWR RF transmission through the use of Jerrold custom designed low-loss, long-life coaxial cable and a complete line of solderless 75 ohm coaxial connectors and fittings. Designed for use with military, commercial and all electronic apparatus.

Jerrold maintains a nation-wide organization of trained sales and field engineers. This experienced staff is always ready to plan, supply or install the equipment or system best suited to your individual needs. Call, wire or write for the name of the Jerrold office nearest you.

